(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
20 September 2001 (20.09.2001)

PCT

(10) International Publication Number
WO 01/69963 A2

(51) International Patent Classification[7]: H04R

(21) International Application Number: PCT/US01/08032

(22) International Filing Date: 13 March 2001 (13.03.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/188,721 13 March 2000 (13.03.2000) US

(71) Applicants: **SARNOFF CORPORATION** [US/US]; 201 Washington Road, CN 5300, Princeton, NJ 08543-5300 (US). **STAR MICRONICS CO., LTD.** [JP/JP]; 20-10, Nakayoshida, Shizuoka 422-8654 (JP). **TIBBETS INDUSTRIES, INC.** [US/US]; 5 Colcord Avenue, Camden, ME 04843 (US).

(72) Inventors: **MAHONEY, Derek, D.**; 1 Quail Court, Manalapan, NJ 07726 (US). **MARGICIN, John, M.**; 53 Danby Lane, Langhorn, PA 19047 (US). **SJURSEN, Walter, P.**; 6 Bankers Drive, Washington Crossing, PA 18977 (US). **POUX, Christopher, J.**; 4 Alton Road, Trenton, NJ 08619 (US). **MORONEY, Richard, M.**; 3 Kensington Court, Princeton, NJ 08540 (US). **URUSHIBATA, Kiyoshi**; 1-23-11-101, Sena, Shizuoka-shi 420-0911 (JP). **YAMADA, Hiromi**; 3100-34, Oya, Shizuoka-shi (JP). **MADAFARRI, Peter**; 16 Bayberry Lane, Camden, ME 04843 (US).

(74) Agents: **REYNOLDS, Leo, R.** et al.; Hamilton, Brook, Smith & Reynolds, P.C., Two Militia Drive, Lexington, MA 02421 (US).

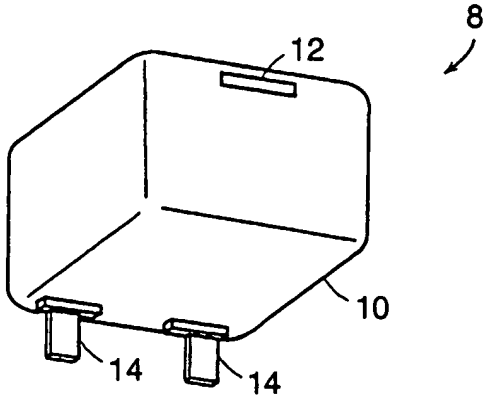
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *without international search report and to be republished upon receipt of that report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: THROUGH-HOLE AND SURFACE MOUNT TECHNOLOGIES FOR HIGHLY-AUTOMATABLE HEARING AID RECEIVERS



(57) Abstract: A hearing aid receiver adapted for automated processing by the use of through-hole and surface mounting characteristics on the receiver assembly. The receiver can include a housing, a bobbin disposed within the housing upon which a coil is wound, and at least two leads being held by the bobbin. The leads extend through at least one opening in the housing with opposite ends of the coil being electrically connected to respective leads.

WO 01/69963 A2

THROUGH-HOLE AND SURFACE MOUNT TECHNOLOGIES FOR HIGHLY-AUTOMATABLE HEARING AID RECEIVERS

BACKGROUND OF THE INVENTION

A hearing aid receiver (sometimes referred to as a speaker) is a device that receives an electrical signal, typically from an amplifier, and converts that signal into a corresponding acoustic (pressure) variation. Since the fabrication of currently available receivers is not highly automated, the price of these units is significant. Also, these receivers do not readily facilitate a high level of automation capability for the production of hearing aids. Part of the problem is that the terminations on a given receiver are solder pads that generally require a manual assembly process involving discrete wire attachment.

SUMMARY OF THE INVENTION

Accordingly, it would be highly desirable to provide a receiver that may be mass-produced in an automated fashion. Additionally, to facilitate hearing aid assembly, it is desirable to impart surface and through-hole mount characteristics to the receivers so produced. Doing so, these receivers (which are to be produced on a highly automated line) may in turn be used in subsequent automated hearing aid assembly processes.

In accordance with one aspect, a receiver, which can be used in a hearing aid, is provided for converting an electrical signal representing acoustic vibrations into a corresponding pressure vibration. The receiver can include a housing, a bobbin disposed within the housing upon which a coil is wound, and at least two leads being held by the bobbin. The leads extend through at least one opening in the housing with opposite ends of the coil being electrically connected to respective leads.

The bobbin and housing can be formed from plastic. In one embodiment, the bobbin includes an end plate having the at least two leads disposed therein. The bobbin can further include a pair of arm members extending from the end plate for supporting the coil and a motor assembly, which can include a coil, armature, and at least two magnets.

The ends of the leads can be curved, such as J-shaped, or gull wing-shaped for surface mounting the receiver to a substrate, such as a printed circuit board.

A hearing aid is also provided comprising a microphone for converting acoustic vibrations into an electrical signal corresponding thereto, and a receiver for converting the electrical signal into an acoustic vibration for coupling to a tympanic membrane of a user. The receiver can include a housing, a bobbin disposed within the housing upon which a coil is wound, and at least two leads being held by the bobbin. The leads extend through at least one opening in the housing with opposite ends of the coil being electrically connected to respective leads.

A receiver for use in a hearing aid is further provided which includes a housing enclosing a bobbin which includes an end plate supporting a pair of leads extending above and below the end plate. The bobbin can further include a pair of arms that extend from the end plate for supporting a coil wound about the arms, wherein respective ends of the coil are electrically connected to respective leads that extend above the end plate, the leads extending through the housing for surface mounting the receiver to a substrate. The arm members can further support a motor assembly which includes the coil, an armature, and at least two magnets.

A method of forming a receiver is provided for converting an electrical signal representing acoustic vibrations into a corresponding pressure vibration, which includes providing a bobbin, winding a coil around the bobbin, attaching the ends of the coil to at least two leads being held by the bobbin, and enclosing the bobbin with a housing with the at least two leads extending through the housing.

The method can further include attaching a motor assembly to the bobbin. In one embodiment, the motor assembly includes the coil, an armature, and at least two magnets. The receiver can be provided within a hearing aid that is insertable into the

ear canal of a user. Additionally, the ends of the leads can be surface mounted to a printed circuit board.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of preferred embodiments of the invention, as illustrated in the accompanying drawings in which like reference characters refer to the same parts throughout the different views. The drawings are not necessarily to scale, emphasis instead being placed upon illustrating the principles of the invention.

FIG. 1 is a perspective view of a receiver in accordance with the invention.

FIG. 2 is a perspective view of the receiver of FIG. 1 with the housing removed.

FIG. 3A is an exploded view of the receiver of FIG. 1.

FIG. 3B is an exploded view of a motor assembly for the receiver of FIG. 1.

FIG. 4 is a perspective view of a bobbin in accordance with the invention.

FIG. 5 shows the bobbin 16 with a coil wound around an arm thereof.

FIG. 6 shows the motor assembly attached to the bobbin.

FIG. 7 is a partial cut-array view of the receiver mounted in a hearing aid.

DETAILED DESCRIPTION OF THE INVENTION

A description of preferred embodiments of the invention follows. Shown in FIGs. 1 and 2 is a hearing aid receiver 8 that incorporates many features that improve the manufacturability of this part. Although it is anticipated that the housing 10 is be constructed from a metal such as Hy-Mu sheet steel, it is feasible that the housing could be made of plastic. The sound port 12 (having a rectangular cross-section), as well as the leads 14 are visible in this figure. These leads are shown in a configuration which would be amenable to through-hole mounting on a suitable substrate (not shown) such as a printed circuit board. (It is assumed that the substrate material will be sufficiently compliant so that mechanical vibrations from

the receiver will be highly attenuated by this material.) Clearly, the leads can be formed into a J-lead or gull wing shape so that the component 8 could become a surface mountable part. The bobbin 16, (shown in detail in FIG. 4), in which the leads are embedded, prevents the leads from shorting to the body of the receiver housing 10. In one embodiment, the bobbin 16 is formed from plastic.

The internal components of the receiver are shown in FIGs. 3A and 3B . Such internal components include the coil 18, armature 20, drive pin 22, diaphragm 24, magnet strap 26, and two magnets 28 (best seen in FIG. 6). The two magnets 28 are required to implement a balanced armature receiver configuration chosen because of its relatively high efficiency and linearity. Highly efficient receivers are particularly desirable due to the receiver's consumption of 50 to 95% of the available power in the hearing aid. Significant reductions to the power demands of the receiver 8 will lead to increased battery life.

FIG. 4 depicts a bobbin 16 suitable for use in the hearing aid receiver 8. This particular bobbin has several important features. One function of the bobbin is to provide structural support for the insert-molded leads 14, while another is to create a frame around which the coil may be wound. The bobbin 16 includes an end plate 36 having a pair of arm members 38 extending transversely therefrom. The end plate 36 structurally supports the leads 14 which extend above and below the end plate.

The location of the coil 18 on the bobbin 16 is shown in FIG. 5. Referring to this figure, the ends of the coil are terminated on one end of each post 14. The opposite end of each post (lead) 14 surface (or through-hole) mounted to a compliant printed circuit board (not shown), although as shown in FIG. 7 discrete wires 32 or ribbon cables may be substituted, if desired. Another function of the bobbin 16 is to provide mounting locations for the magnets and magnet strap (see FIG. 6). Finally, since the bobbin 16 mates with the armature, as shown in FIG. 3B, the entire motor assembly 30, which includes the coil 18, armature 20, and magnets 28, is conveniently and compactly attached to the bobbin 16.

The incorporation of the motor assembly 30 including a bobbin 16 into the receiver 8 allows a high level of automation in the receiver production, while the use of surface and through-hole mountable leads permits the receiver to be use in an

automated hearing aid assembly process. These automation processes will result in the ability to produce high-volume, high-quality, and low-cost receivers. The reduced cost of the receivers will have a positive ripple effect on the cost of the hearing aid 34 shown in FIG. 7 wherein a finished receiver 8 is shown placed inside of a hearing instrument.

While this invention has been particularly shown and described with references to preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the scope of the invention encompassed by the appended claims.

CLAIMS

What is claimed is:

1. A receiver for converting an electrical signal representing acoustic vibrations into a corresponding pressure vibration comprising:

a housing;

a bobbin disposed within the housing upon which a coil is wound; and

at least two leads being held by the bobbin, the leads extending through at least one opening in the housing, wherein opposite ends of the coil are electrically connected to respective leads.

2. The receiver of Claim 1, wherein the receiver is disposed within a hearing aid.

3. The receiver of Claim 1, wherein the bobbin includes plastic.

4. The receiver of Claim 1, wherein the housing includes plastic.

5. The receiver of Claim 1, wherein the bobbin includes an end plate having the at least two leads disposed therein.

6. The receiver of Claim 5, further comprising a pair of arm members extending from the end plate for supporting the coil.

7. The receiver of Claim 6, wherein the arm members support a motor assembly.

8. The receiver of Claim 7, wherein the motor assembly includes the coil, an armature, and at least two magnets.

9. The receiver of Claim 1, wherein the ends of the leads are J-shaped for surface mounting the receiver to a substrate.

10. The receiver of Claim 1, wherein the ends of the leads are gull wing-shaped for surface mounting the receiver to a substrate.

11. A hearing aid comprising:

a microphone for converting acoustic vibrations into an electrical signal corresponding thereto;

a receiver for converting the electrical signal into an acoustic vibration for coupling to a tympanic membrane of a user, the receiver including:

a housing;

a bobbin disposed within the housing upon which a coil is wound; and

at least two leads being held by the bobbin, the leads extending through the housing, wherein opposite ends of the coil are electrically connected to respective leads.

12. The receiver of Claim 11, wherein the bobbin and the housing include plastic.

13. The receiver of Claim 11, wherein the bobbin includes an end plate having the at least two leads disposed therein, the bobbin further comprising a pair of arm members extending from the end plate for supporting the coil.

14. The receiver of Claim 13, wherein the arm members support a motor assembly which includes the coil, an armature, and at least two magnets.

15. The receiver of Claim 11, wherein the ends of the leads are curved for surface mounting the receiver to a substrate.

16. The receiver of Claim 15, wherein the substrate includes a printed circuit board.

17. A receiver for use in a hearing aid, comprising a housing enclosing a bobbin, the bobbin having an end plate supporting a pair of leads extending above and below the end plate, the bobbin further including a pair of arms extending from the end plate for supporting a coil wound about the arms, wherein respective ends of the coil are electrically connect to respective leads that extend above the end plate, the leads extending through the housing for surface mounting the receiver to a substrate.

18. The receiver of Claim 17, wherein the arm members support a motor assembly which includes the coil, an armature, and at least two magnets.

19. A method of forming a receiver for converting an electrical signal representing acoustic vibrations into a corresponding pressure vibration, comprising:

providing a bobbin,

winding a coil around the bobbin;

attaching the ends of the coil to at least two leads being held by the bobbin; and

enclosing the bobbin with a housing, the at least two leads extending through the housing.

20. The method of Claim 19, further comprising attaching a motor assembly to the bobbin, the motor assembly including the coil, an armature, and at least two magnets.

21. The method of Claim 19, further comprising providing the receiver within a hearing aid that is insertable into the ear canal of a user.

22. The method of Claim 19, further comprising surface mounting the receiver to a printed circuit board with the ends of the leads.

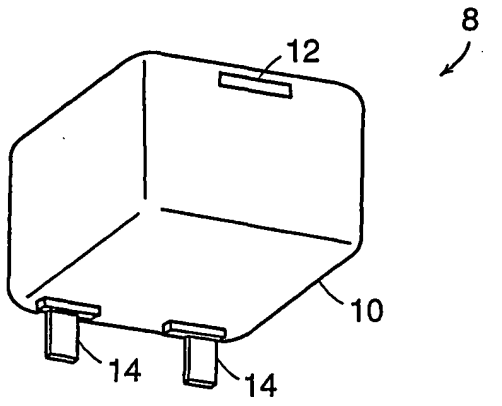


FIG. 1

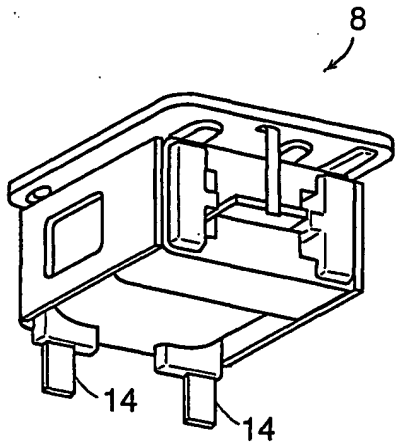


FIG. 2

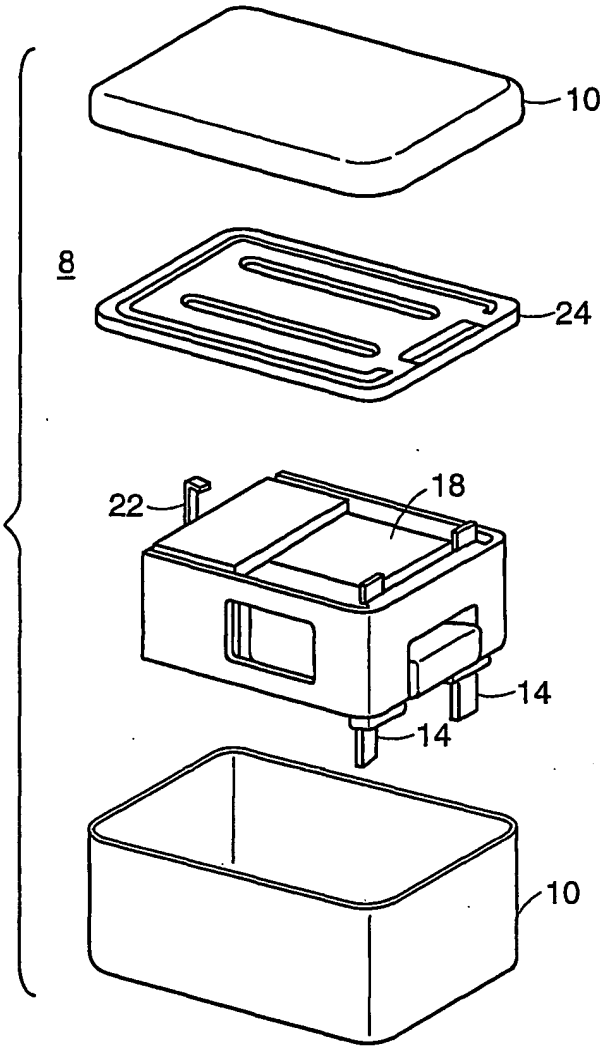


FIG. 3A

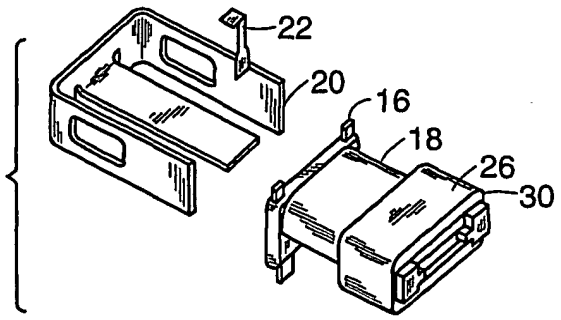


FIG. 3B

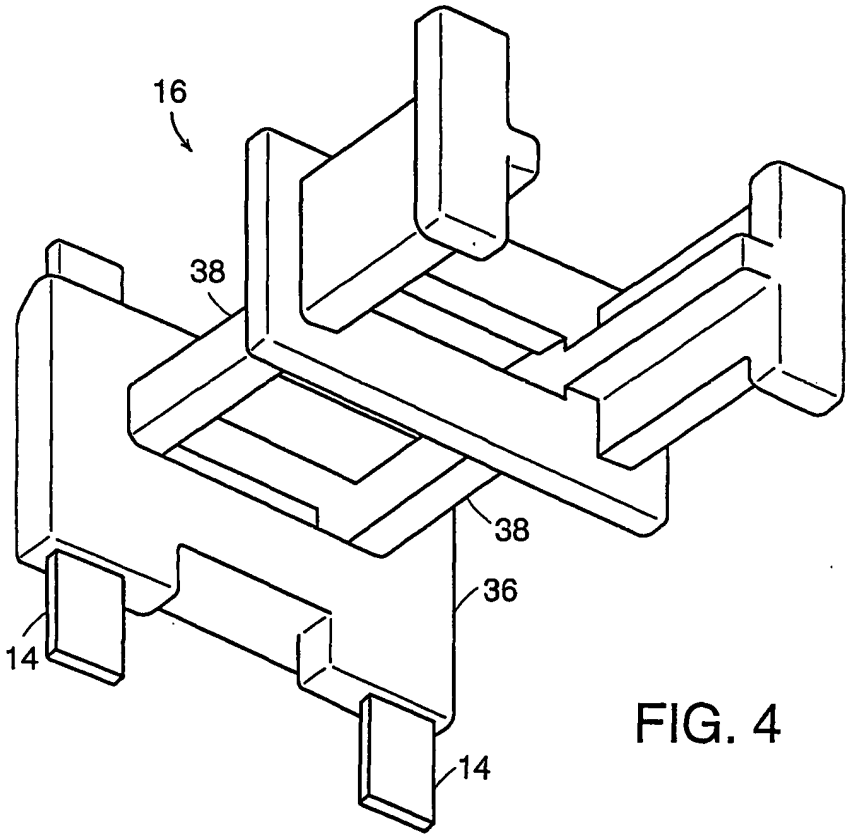


FIG. 4

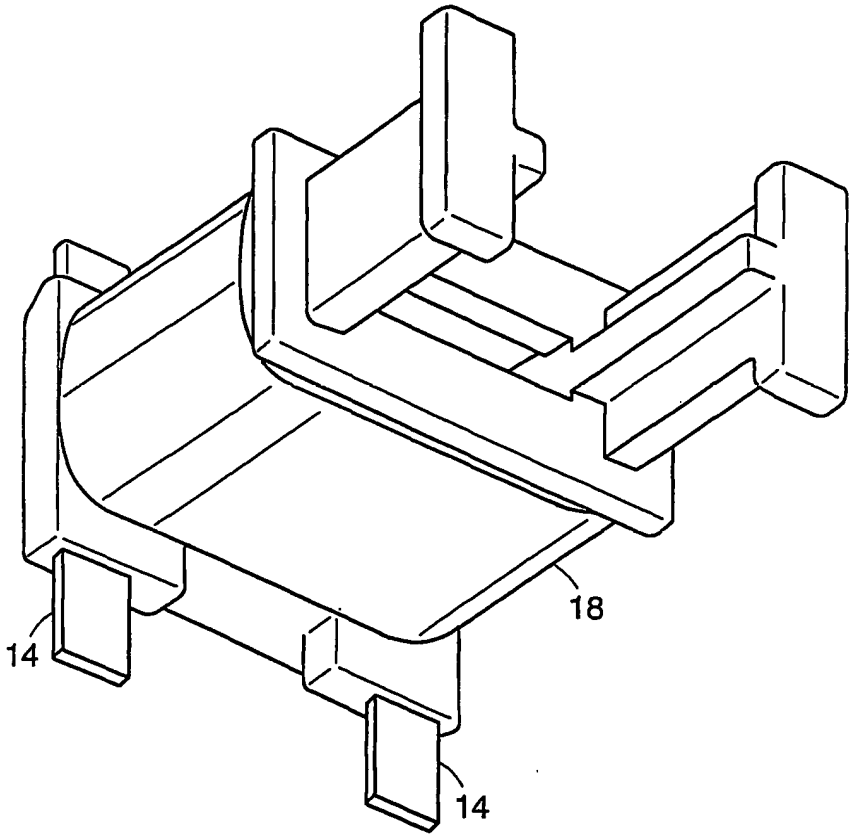


FIG. 5

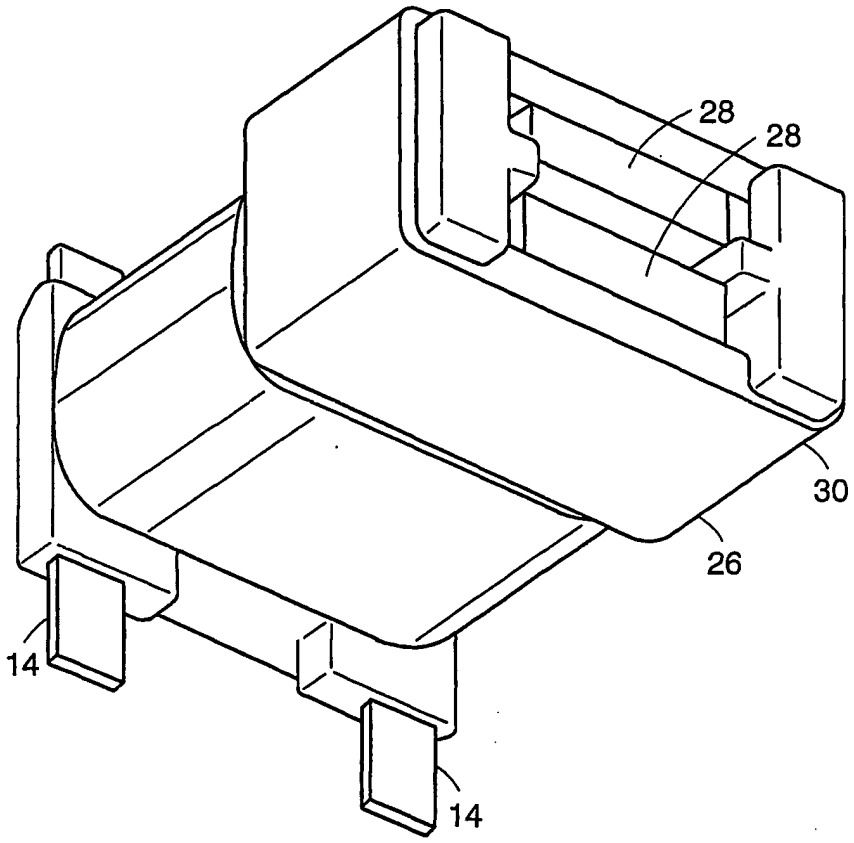


FIG. 6

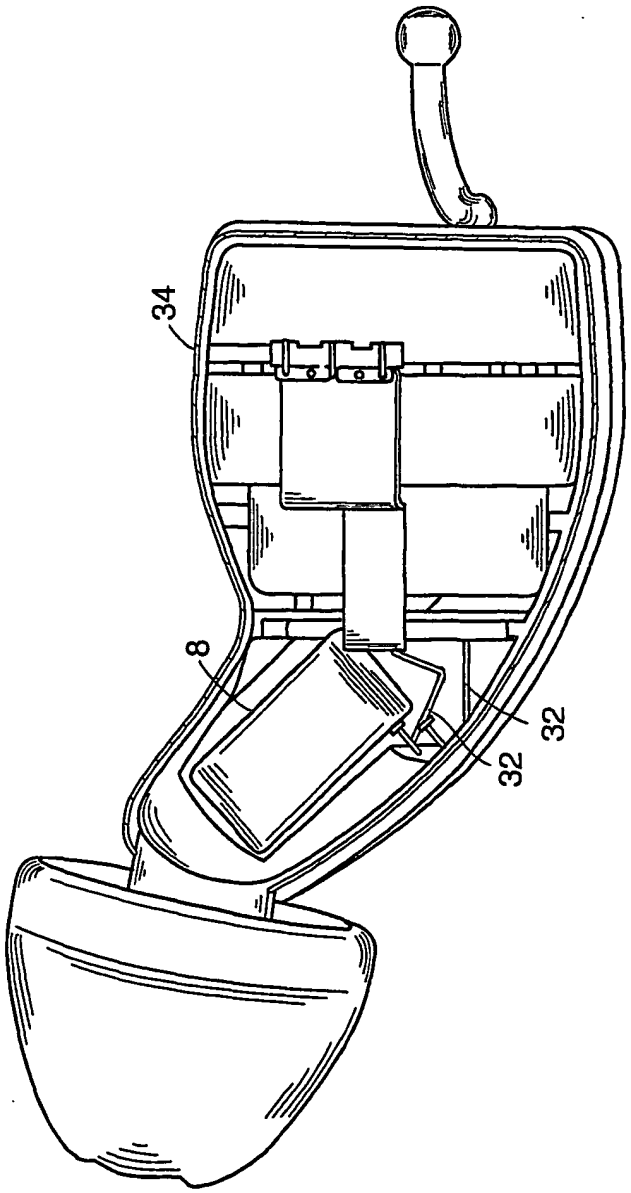


FIG. 7